THE MECHANICAL PROPERTIES OF PALM OIL FIBER REINFORCED POLYPROPLENE COMPOSITIES

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DECLARATION

I declare that this project report entitled “The mechanical properties of palm oil fiber reinforced polyproplene ” is the result of my own work except as cited in the references

Signature	:	....
Name	:	....
Date	:	....

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering with Honors.

Signature :. ....

Name of Supervisor : ....

Date : ....

DEDICATION

To my beloved parents,sibling and supervisor.

Thank you for all your support.

ABSTRACT

Natural fibers have been available for the replacement of luxury and non-renewed synthetic fibers in recent times as outstanding materials. In the last few years, many of the natural fiber used in the composite thermoplastic have been sisal, sugar cane, kenaf, palm oil and jute. Furthermore, the process of compounded materials between natural fibre and thermoplastic are for the applying it in the manufacturing of automotive, construction, furniture and goods industry. Palm Oil Fiber (POF) is a natural fiber with a good potential to strengthen thermoplastics and create a new top composite material. Therefore, this phenomenon was linked to this research which aimed at investigating the mechanical properties of polypropylene-backed POF (PP) as a matrix with varying weight of fibre, to identify PP-built physical properties of POF and to analyze the POF / PP composite microstructure. The process started with raw pineapple leaf preparation and was then alkalinized. By using the hot press and the cooling machine, POF and PP were combined with a hot compression process to create a sample. The samples have been developed for tensile tests (ASTM D3039), density tests (ASTM D792) and hardness tests (ASTM D2240) according to the standard requirements. The composition structure between fiber and matrix composite is investigated by the Scan electron microscope (SEM). The result showed a linear decrease in tensile testing and in maximum load for POF / PP composites with increasing fiber loading. The fiber loading was, however, up linearly with the density trend but decreasing with hardness. The study shows that the composition structure of POF / PP is best achieved by 10 wt % fiber loading.

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ABSTRAK

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Pada masa kini, serat semulajadi wujud sebagai bahan yang luar biasa yang menjadi bahan penting untuk menggantikan serat sintetik mewah dan serat tidak dapat diperbaharui.Sejak beberapa tahun kebelakangan ini, banyak serat semulajadi seperti sisal, pisang, kenaf, kelapa sawit dan jut telah digunakan sebagai pengukuhan dalam komposit termoplastik. Selain itu, proses bahan yang diperbuat antara serat semulajadi dan termoplastik kebanyakan digunakan dalam industri automotif,pembinaan,perkakas perabot dan lain-lain.Serat kelapa sawit juga mempunyai potensi yang besar untuk menjadi bahan-bahan penguat termoplastik dan menjadikan sebuah bahan komposit baru yang unggul.Tujuan kajian disebabkan semangat ingin tahu sifat mekanikal serat kelapa sawit apabila diperkuatkan dengan PP sebagai matriks.Kajian dilakukan dengan pelbagai nisbah PP dengan POF menganalisis struktur mikro POF / PP .Proses ini bermula dengan pendapatkan bahan mentah serat kelapa sawit dan kemudian dirawat dengan rawatan alkali.Mesin tekanan panas dan sejuk digunakan untuk meghasilkan sample komposit.Sample komposit tersebut akan diujikajikan dengan ujian tegangan (ASTM D3039), ujian ketumpatan (ASTM D792) dan ujian kekerasan (ASTM D2240).Mikroskop elektron pengimbas (SEM), digunakan untuk menyiasat struktur komposisi antara komposit serat dan matriks. Berdasarkan keputusan kajian mendapati ketumpatan meningkat secara mendatar tetapi kekerasan semakin berkurangan.Kajian ini menunjukan struktur komposit POF/PP yang terbaik adalah 10 wt%.

ACKNOWLEDGEMENT

Alhamdulillah, thanks to Allah S.W.T for giving me a chance to complete my research for this final year project with the title, “The mechanical properties of palm oil fiber reinforced polyproplene composites”.

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LIST OF SYMBOLS AND ABBREVIATIONS

Polymer Matrix Composites	-	PMC
Metal Matrix Composites	-	MMC
Ceramic Matrix Composites	-	CMC
Carbon and Graphic matrix composites	-	CGMC
Polypropylene	-	PP
Sodium Hydroxide	-	NaOH
High Performance Concrete	-	HPC
Palm Oil Empty Fruit Bunch	-	POFEFB
Palm Oil Fiber Empty Bunch	-	POFEB
Polyethylene	-	PE
Polystyrene	-	PS
Palm Oil Institute of Malaysia	-	MPOB
Fiber Reinforced Polymer	-	FRP
Palm Oil Empty Fruit Brunch	-	POEFB
Palm Oil Fibre	-	POF
Palm oil reinforced rubber composite	-	PORC

CHAPTER 1

INTRODUCTION

1.1 Background

Malaysia is the rich country with plenty of natural plants growing in the rainforest. Malaysia has many types of natural plants such as palm oil, kenaf, pineapple, orchid and others. Researchers take this opportunity to find out the benefits of natural plants and to develop new innovative and alternative products that are more environmentally friendly, cheaper and economical Most researchers find out the advantage of natural plant fiber to develop a new product. Natural fibers are generally known as vegetable fibers extracted from the plant's fruit, phloem, or leaf. Recently, many types of natural fibers are being studied to reinforce with polymer such as flax, hemp, jute, straw, wood fiber, rice hunks, sugar and bamboo cane, grass, reeds, ramie, empty fruit bunch, sisal, coir, kapok, banana fiber, pineapple leaf fiber and papyrus. Most of the natural fiber is used for automotive components, clothes and construction. Many researchers studied the advantages of natural fiber reinforcement with polymer such as polystyrene (PS), polyester, epoxy, polyethylene (PE) and polypropylene (PP). On the morphology and properties of polypropylene (Dikobe & Luyt, 2009), polypropylene (PP) has been found to be one of the most widely used product polymers in many areas, such as home appliances, industrial applications and automotive components. The characteristic PP is low impact strength, the module properties of Young, low temperature and high temperature loading conditions. Method for improving the PP properties by mixing and mixing it with other polymers.

Composite material is defined when two or more different materials combine to create new physical and chemical properties for better results. The good things about combining materials are their high strength and rigidity. (Paul Wambua, Jan Ivens, Ignaas

Verpoest, 2003) conducted natural fiber replacement studies in fiber-reinforced plastics. They were research on the mechanical properties of polypropylene reinforced by kenaf, coir, sisal, hemp and jute. They found the natural resource reinforced with polypropylene had found tensile strength and module increases with increasing fiber volume fraction They also found some natural fiber that can cover high impact strength and can replace the glass as alternative materials. (H. Ku, H. Wang, N. Pattarachaiyakoop & M. Trada, 2011) studied the tensile properties of natural fiber reinforced polymer composites. They found that the strength and stiffness of natural polymer fiber composite was strong but dependent on the amount of fiber. They also found that the tensile strength and module will increase when the fiber weight ratio rises to a certain amount. This shows that natural fiber reinforcement with polymer can have a good impact on industry in finding alternative materials that are more economically and environmentally friendly.

Malaysia is rich with different plants and climate equator. This climate offers the opportunity to become the second largest palm oil plantation after Indonesia. Production based on palm oil is about 90 million tons of lignocellulosic biomass including oil palm trunk, palm fronds and empty fruit bunches. Production of palm oil produces a lot of waste such as coir and trunk palm oil. Malaysia is setting up the Palm Oil Research Institute of Malaysia (MPOB) to maximize palm oil production and reduce palm oil waste. Therefore, in thermoplastics and thermoset, many researchers discover and conduct research to investigate the effects and benefits of palm oil coir fibers(Maya Jacob, Sabu Thomas, K.T. Varughese, 2003) presented the mechanical properties of natural rubber composites reinforced by sisal / oil palm hybrid fiber. The effect of fiber loading, fiber ratio and alkaline treatment in a study. The show palm oil reinforced rubber composites (PORC) is had strong strength when load applied on it. This PORC show had a strong durability to any condition. The composites tensile and tear strength properties depend on the fraction of the volume. This study was very useful with high quality composite strength. Recently, palm oil fiber is suitable for the manufacture of automotive component belt conveyor, rope hand break and rope break due to mechanical properties. The PORC can also be applied to building construction because it has strong durability and hard to damage.

Saxena & Pappu, 2011, presented recent trends and future potential on natural resource composite materials that discovered the benefits of natural fiber reinforcing composite polymers. This substitution offers many advantages such as lower cost, energy savings, reduced tool wear and tear, high stability for manufactured parts, good insulation properties, renewable, easy to recycle, no toxicity material and reduced fossil fuels. This natural fiber is also used in automobiles such as trim parts, various panels, shelves and brakes that attract in the automotive industry due to its weight reduction of 10 percent, energy production of 80 % and cost reduction of 5 %.

Based on the findings, palm oil coir fiber as natural fiber has an advantage used to reinforce polymer composites. Few researchers presented composites using natural fiber such as palm oil and bamboo fiber. Therefore, this research focuses on the mechanical properties of POF/ PP applied to automotive components, glass, building construction and others.

1.2 PROBLEM STATEMENT

The Industrial Revolution transition took place around 1760 from the manufacturing method to the machine. The industrial revolution continued until today. The modern era, the trend automotive industries have competed to launch new cars with a variety of sophisticated features to attract customer buy car from their brand. Mostly, today's automotive industries are using synthetic materials to manufacture parts of automotive components such as aluminum, glass, steel, copper, rubber, iron, plastic steels and others. These parts are used to create dashboard needles, wiring, engine block and gears for transmission. However, the uncertainty price of synthesis materials nowadays will have a bad impact on the cost of automotive production and decrease the profit of the automotive industry.

1.3 OBJECTIVE

1.3.1 To investigate the mechanical properties palm oil fibre reinforced with polypropylene(PP) as matrix with varying fiber weight fraction.

1.3.2 To identify the physical properties of polypropylene (PP) reinforced palm oil fiber.

1.3.3 To analyze the microstructure of palm oil fiber polypropylene (PP) composites.

1.4 SCOPE

The scope of research are:

1.4.1 Preparation of Palm Oil Fiber Empty Fruit Brunch

1.4.2 Treatment of fiber-alkaline treatment (NaOH solution)

1.4.3 Preparation of polypropylene (PP)

1.4.4 Preparation of sample (composite material) – Compounding of POF and polypropylene polymer by using ball mill and hot press machine.

1.4.5 Testing to find out mechanical properties

(i) Tensile test (ASTM D3039)

1.4.6 Investigate and testing the physical properties:

(i) Density test (ASTM D792)

(ii) Hardness test (ASTM D2240)

(iii) Microstructure analysis (SEM)

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The chapter covers an overview of previous research on composite, natural fiber, palm oil and polypropylene. The purpose of this study is to link the theory of fiber-reinforced polymer composite with the research's main objective. This chapter will review studied exploring palm oil and the advantages of natural fiber and method or material influence the mechanical properties of composites among various polymers.

2.2 Composite

Based on research (Klaus Friedrich & Abdul Hakim A. Almajid, 2012), composite materials have a bright future in high-range, extremely light machine components in the automotive and aerospace industries. Thermoplastics are more advantageous than thermoset because it has low processing costs, ease of moulding complex parts, flexibility, toughness and good mechanical properties. Refer to table 2.1, nowadays the trend towards the manufacture of cars using quantities of composites for hybrids and battery electric vehicles to reduce mass and extend driving range. The advantages of composite in automotive and aerospace can reduce weight production by 20-40 percent, reducing tooling costs, reducing assembly costs, corrosion resistance, and reducing noise vibration hardness and higher damping. The industry is more composite-focused because it has innovation capable of adding low-cost value and safer structure because it has higher specific energy absorption.

Table 2.1: Properties of conventional metals and some advanced composite in automotive industry.

Material	Density(ρ) g/cm3	Tensile Modulus(E)	Tensile Strength (σ)	E / ρ	σ / ρ
Al 6061-T6	2.70	68.9	310	25.7	115
SAE 1010 steel (cold steamed)	7.87	207	365	26.3	46.4
Ti-6Al-4V	4.43	110	1171	25.3	26
Polyamide66	1.14	2	70	1.75	61.4
Unidirectional HS carbon fiber/epoxy	1.55	138	1550	88.9	1000
Unidirectional E-glass fiber/epoxy	1.85	39.3	965	21.2	522
Unidirectional aramid fiber/epoxy	1.38	75.8	1378	54.9	999
Quasi-isotropic carbon fiber/epoxy	1.55	45.5	579	29.3	374
Random glass	1.55	8.5	110	5.48	71

M. Assarar,2010 presented the effect of water ageing on mechanical properties and damage between flax-fiber and glass fiber. The flax fiber is from natural fiber such as hemp, sisal, bamboo and jute to reinforcement with polymer. The research founds out the failure stress properties is slight decrease with immersion time. The both fibers are durable and not easy lost mechanical properties. This show composite suitable to apply in manufacturing industry, automotive and construction where material usually exposed to unpredict weather.

Based on the studies by (Alireza Ashori, 2016) has mentioned that composite contain plant fiber and thermosets or thermoplastic. The unique and superior feature in any plant fiber composite reinforce with thermoplastic have high strength and stiffness cost, low density and low carbon dioxide emission, biodegradability and annually renewable. The composite more environment friendly in industry automotive. Many components made from composite materials such as trim parts in dashboards, door panels, parcel shelves, seat cushions, backrests and cabin linings. The plant fiber composite enhances mechanical strength and acoustic performance, reduce material weight, energy/fuel consumption and processing time, lower production cost, improve passenger safety and shatterproof performance under extreme temperature changes, and improve biodegradability. The plant fiber had high potential to research and develop in green industry.

2.3 Natural Fiber

Fiber can be defined as hair-like materials that are continuous filaments or discrete elongated pieces that are like thread pieces. The fibers can be spun into filaments, thread, rope and matted into sheets to make paper or felt. Fibers can be used as a composite material component. Fibers are two types; natural fibers and synthetic fibrate researchers are more focused on producing composite products based on natural fiber.

Natural fibers are plant and animal substance extracts. Five categories of natural plant fibers are seed fiber, leaf fiber, bast fiber, fruit fiber and stalk fiber. The fiber of seeds collected from seeds. The leaf fiber extracted from a leaf's cells. The bast fiber extracted from the cells of the plant's outer cell layers. Fruit fiber collected from plant fruits such as coconut coir fiber and palm oil coir fiber. Stalk fiber extracted from plant stalks such as bamboo.

Table 2.2: Mechanical properties of some important natural fiber.

	Tensile Strength	**Elongation**	**Toughness**
Fiber	(MPa)	(%)	(MPa)
Sisal	580	4.3	1,250
Pineapple	640	2.4	970
Banana	540	3.0	816
Coir	140	25.0	3,200
OPEFB fiber	248	14	2,000
Palm oil mesocarp fiber	80	17	500

Refer to article (M.S Sreekala M. G. Kumaran, Sabu Thomas,1997) Table 2.2 above shows the mechanical properties of palm oil and other natural fibers had the potential to develop and innovate the product in industrial packaging, automotive and construction. Natural fibers are low cost, light weight, low density, less pollution attracts interest from the researcher to find the best alternative to replace some component with low cost but superior mechanical properties, especially in the automotive and aerospace industries.

Rozyanty Rahman, Syed Zhafer & Firdaus Syed Putra,2016 conducts a study of differential mechanical properties between natural fiber and polymer-reinforced synthetic fiber. The famous natural among researchers are flux, hemp, jute, sisal, kenaf, coir, banana, and henequen, while the famous synthetic fiber is glass, carbon, and aramic. Four factors influence the mechanical properties of composite based on the article. The first factor is properties of fiber. Second factor is properties of polymer matrix. Third is ratio of fiber to polymer matrix. Fourth is orientation and geometry of fiber in composite. With ad chemical treatment, hydrophilic nature of natural fiber can improve adhesion between reinforcement and matrix resin. The ratio and type of chemical treatment affects the mechanical properties of the composite and the thickness of the plate. Table 2.3 shows the effect of natural fiber treatment on plate thickness.

Table 2.3: The result effect natural fiber after treatment.

Fiber	**Treatment**	**No. of ply**	**Stacking sequence**	**Thickness(mm)**
Hemp	Untreated	4	[0/90]1s	1.364
Hemp	Alkaline treatment NaOH 1%	4	[0/90]1s	1.511
Hemp	Alkaline treatment NaOH 5%	4	[0/90]1s	1.679
Hemp	Silane treatment 1%	4	[0/90]1s	1.471
Hemp	Silane treatment 5%	4	[0/90]1s	1.460
Hemp	Silane treatment 20%	4	[0/90]1s	1.450